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CIRCULAR—NO. 138

CERTAIN GEOLOGICAL CONDITIONS THAT CAUSE COAL MINING FATALITIES

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Reprinted from The Illinois Engineer
October, 1947

PRINTED BY AUTHORITY OF THE STATE OF ILLINOIS

URBANA, ILLINOIS
1947

Certain Geological Conditions That Cause Coal Mining Fatalities *

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The mining and production of coal underground has long been recognized as one of the nation's as well as the State's most hazardous industries. Tabulated data reveal that since 1882 there have been 7,789 men killed in Illinois in mining accidents of one form or another. Further inspection of the data indicates that 3,711 of these men were killed underground by falls of roof rock. This amounts to 47.64 percent of all mining accidents above ground and below and including coal stripping operations.

The following table breaks down the total period of time into three groups:

1. A period of beginning, when total State production was less than 15,000,000 tons annually, 1882-1890.
2. A period of stability, when mining methods remained essentially unchanged, 1891-1930.
3. A period of mechanization, beginning in 1930, when 50 percent of total State production was mechanically produced, 1931-1945.

and, therefore, must be considered as general industrial accidents. Discussion in this paper is limited to those accidents that are a result of rock falls. Directly or indirectly, all of these accidents are a function of the ability to establish really effective control of the roof, ribs, and floor in the area where mining is to be conducted.

Present day knowledge of roof-control is extremely limited, and the normal procedure in selecting control measures is largely a matter of expediency, limited by the knowledge and experience of the person in charge. Since mechanized mining requires close control and accuracy, the day has arrived when management cannot "drop rooms" or move the location of entries to satisfy local conditions of bad-top. Successful competition demands exact and long-range planning; every ton of coal that is to be mined must be included in these plans, and the method and time of recovery is determined far in advance of the actual mining. Ideally, the solution to mine safety would be the elimination of the necessity of working under the hazardous materials. Such a solution is obviously impossible. This leaves two methods of helping to eliminate these mining hazards:

TABLE OF MINE FATALITIES

Group	Years	Total Killed	By Falls	% by falls	Tons mined	Tons/death	Tons/fall death
1	1882-1890	502	270	53.8	95,134,164	215,094	362,630
2	1891-1930	5,975	2,759	46.1	1,946,607,124	328,225	684,899
3	1931-1945	1,312	682	52.0	795,429,331	614,784	1,174,464
Total	1882-1945	7,789	3,711	47.64		362,291	765,515

Although the tabulation reveals a considerable decrease in fatal mining accidents, it does not bring out the fact that much of the improvement is a result of mining migration, that is, a shift of mining enterprise from areas where bad mining conditions exist, to areas where conditions are better. Mining operations carried on under bad-top conditions are not only more hazardous, they are also more expensive. It is almost impossible to determine the relative safety value in the above mentioned migration but the final result is rather simple. The effect is a gradual concentration of mining in good areas and a corresponding decrease of production in bad areas.

When any company has in mind the adoption of mechanical equipment for a mining operation, whether it be new or old, the proposed equipment must be considered from a safety standpoint. With the exception of mine explosions, only those accidents involving falls of materials from the top, rib, or face during mining can be regarded as true mining accidents. All other types of accidents are just as typical of other industries

1. Attempt to design and select mining equipment in such a way that the face hazards are eliminated or reduced to a minimum. Such a plan should consider the following features of equipment design:
   a. How close must the equipment operator approach the mining-face prior to permanent face support?
   b. How easily is the equipment controlled?
   c. How much time may the operator use in making observations of the immediate working area without interfering with proper equipment operation?
   d. How long does the use of the equipment delay the installation of permanent roof support?
   e. How much does variation of height and width of the working-place affect the safe operation of the equipment?

The above factors are so interrelated as to make separate consideration virtually impossible. The requirement is, however, that the greatest protected working area be provided for the greatest amount of time.

2. Attempt to solve the problems of roof-control by study and research. Such a program of study would be

*Published by permission of the Chief, Illinois State Geological Survey, Urbana, Illinois. Presented at the annual meeting of the Illinois State Academy of Science, Peoria, Illinois, May 2, 1947.

concerned with a study of types of roof materials and their reactions. Results should give a better understanding of the conditions which govern the distribution of types of roof, the nature of the distribution, and a better understanding of the factors contributing to poor or bad roof conditions and methods of overcoming them.

Greater success can probably be expected in a program of research than from attempts to change the design of equipment. Special design of equipment for each set of conditions would increase equipment costs to impractical levels.

In undertaking a program of research, as outlined above, a certain amount of industrial resistance can be expected. Ordinarily, coal mining men consider geology as a science that serves to indicate the presence or absence of a mineable vein of coal and, possibly, some of its more prominent mining characteristics. ''Geology,'' they say, ''becomes useless when applied to such a practical problem as that of controlling the roof-material overlying the coal veins.'' This attitude is a result, at least in part, of the failure of mining people to realize the importance of geologic influences in roof-control problems. Roof-fall accidents have been shown to account for 47.64 per cent of all accidents charged to the coal mining industry. These same roof-fall accidents, moreover, account for the majority of the true mining deaths; only those from explosions are to be excepted. Geologic factors are commonly the unsuspected cause for these roof-fall accidents. Faulty interpretation of the following examples are cited:

TYPE I. Roof-falls in areas with previously unsuspected lithologic variability.

Very commonly, after an accident from a roof-fall, the roof is observed to be different from what the visible portion, prior to the accident, had indicated. Because certain critical sedimentary features were undetected or ignored, working conditions were declared safe and satisfactory, whereas they were unsafe.

The Report of Casualties from the State of Illinois Department of Mines and Minerals gives an example saying:

> "The deceased, an entry man, apparently was loading coal about 10 feet from the face of the main north entry when he was caught under a fall of rock about 18 feet by 18 feet by 10 inches thick. This fall consisted of a large number of boulders which were not visible before they fell and they probably caused the fall. The roof had appeared to be normal and this faulty condition had not been detected. Props were set on one side of the track, several of which were under part of the roof which fell, but they could not support it under these conditions."

It would seem well within the realm of possibility that had there been detailed inspection of the roof evidence, such a condition would have been detected prior to the fall.

TYPE II. Roof-falls as a result of unexplained pressures in top materials.

When mining is being carried out beneath more or less consistent materials, falls sometimes occur without warning. Frequently the fall is accompanied by a chipping or cutting of the top, the line of cutting usually running parallel with the direction of advance, and ordinarily developing in advance headings or rooms. Usually the top material falls in benches, progressively breaking higher.

The Report of Casualties from the State of Illinois Department of Mines and Minerals gives an example saying:

> "The deceased was a driller and he was drilling in a room, next to a room where a loading machine was operating. Top-coal fell and caught the loading machine operator against the loading machine. His helper called for help, and three men came to assist in getting him out; while they were trying to move him the machine operator noticed the top slate chipping. The other men told him to lay close to the loading machine, and the three men ran out of the room as the slate began to fall. As they ran out of the room, the deceased came into the room through a cross-cut and was caught under the fall of slate, killing him instantly."

Accidents, such as this, are of the type some mining men prefer to call ''pressure-cutting.'' The evidence offered shows:

1. A very slight bending or ''weight'' of the roof.

2. Cutting or checking of the roof, very much like a tension crack, usually parallel to the direction of advance.

3. If a drill-hole is placed over the roof so affected, many times enough gas can be released to be ignited. Many times such drill-holes will stop the ''weight.''

Apparently the phenomenon is a result of included gas, moisture, or chemical changes developing rather high localized pressures; thereby, bending develops in the top-material. If the material happens to be relatively weak, it breaks.

TYPE III. Falls resulting from pre-existing roof fractures.

One of the more common types of roof-fall accidents takes place where there are ''slips'' or ''faults'' crossing the roof strata. Ordinarily, such fractures are evident,

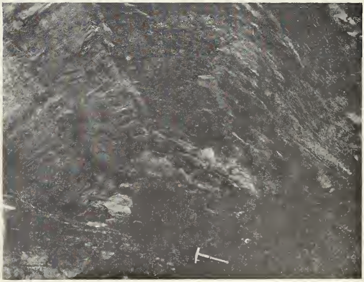

FIG. 1. Two opposite dipping slips, a condition responsible for the fatal injury of a workman.

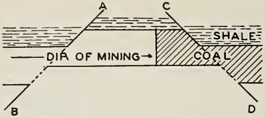

FIG. 2. Diagrammatic illustration of two opposite dipping slips.

and proper appreciation of the hazard represented by such conditions would eliminate many accidents. However, human negligence is great. Many times the fractures are hidden or ignored.

A good example of this type roof-fall, illustrating a case where the slip had gone undetected, is given in the Casualty Report of The State of Illinois Department of Mines and Minerals.

> "This accident caused the death of two men. These two men were miners working in a new operation about 20 feet in an entry off of the bottom. They had shot some slate down and were making a grade for a material entry. These two were breaking up some rock to use in grading when a large piece of rock fell on them. This rock was hanging over the rib and a slip was going along the side which probably caused it to fall and they thought it was safe. The rock was 6 to 8 feet long, 4 to 5 feet wide, and 2 feet thick in the center."

The above is typical of the slip-type roof-fall which occurs in a multitude of varieties. Almost as common as the variety discussed above, with only one slip affecting the top material, is a far more dangerous form where two or more slips occur with opposite dips. See Figures 1, 2 and 3.

Conclusions

These three types of roof instability result from geologic influences. They are only suggestive of the general importance of geology in the problem of roof-control.

FIG. 3. The result of three intersecting slips.

Its full importance will be more specifically defined and limited when more research has clarified the conditions that govern the distribution of types of roof, the nature of the distribution, and we have a better understanding of the factors contributing to bad-roof conditions along with the methods of overcoming them. The systematic assembly of geologic information covering roof-materials should give an improved basis for evaluating the results of exploration by various drilling methods, thereby improving roof-control methods when mining Illinois coal.

In order to carry out the above research it will be necessary to devise some method for the clarification of present terminology used in mining. Such terms as: bad-top, clod, white-top, rolls, nigger-heads, etc., must be more specifically defined and used so that conditions can be correctly interpreted.